

THE WOOD ANATOMY OF *ALLANTOSPERMUM BORNEENSE* FORMAN AND *ALLANTOSPERMUM MULTICAULE* (CAPURON) NOOTEBOOM

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SUMMARY : Timbers'anatomy of *Allantospermum borneense* Forman and *Cleistanthopsis multicaule* Capuron. This study shows the main difference in anatomical features between two species of *Allantospermum*. By its wood pattern, *Allantospermum* is different from *Ixonanthoideae* and also from *Irvingioideae*.

RÉSUMÉ : Cette étude sur l'anatomie du bois adulte d'*Allantospermum borneense* Forman et de *Cleistanthopsis multicaule* Capuron montrent les principaux caractères anatomiques par lesquels diffèrent ces deux espèces d'*Allantospermum*. Par son type de plan ligneux *Allantospermum* est différent à la fois des autres genres d'*Ixonanthoideae* et d'*Irvingioideae*.

INTRODUCTION¹

In 1965, publications of two new species with identical morphological descriptions appeared in two scientific bulletins. The new species described by FORMAN (6) was published a day ahead of that of CAPURON (2). FORMAN included his new species to the family *Ixonanthaceae* while CAPURON placed his new species to the family *Irvingiaceae*. FORMAN's addition of *Allantospermum borneense* prompted him to combine the families *Ixonanthaceae* and *Irvingiaceae*, retaining the former as the family with *Ixonanthoideae* and *Irvingioideae* as subfamilies. However, NOOTEBOOM (14), according to HUTCHINSON (10), recently reduced CAPURON's *Cleistanthopsis* to *Allantospermum* Forman resulting in a new combination, *Allantospermum multicaule* (Capuron) Nootboom. NOOTEBOOM disagreed with FORMAN that *Allantospermum* belongs to *Ixonanthaceae*. His review of morphological characters and results on chemical (phenolic) studies of the *Allantospermum* species, showed its closeness to *Irvingioideae*. He argued that absence of mucilage canals and cavities in *Allantospermum* does not exclude its close affinity to *Irvingioideae*; rather, it is a difference between *Allantospermum* and the species of *Irvingioideae*. NOOTEBOOM concluded that *Irvingioideae* should be treated as belonging to *Simaroubaceae* until biological sciences could provide convincing evidence for a better classification of the taxon in question.

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1. Number in parenthesis refers to *Literature Cited* at the end of this paper.

REVIEW OF LITERATURE

Irvingiaceæ has been considered by earlier authors as a distinct family. JADIN (11), in his anatomical studies of the stems, leaves and petioles of the *Simaroubaceæ*, suggested that species of *Irvingia*, *Klainedoxa* and *Picrodendron* should be considered separate from *Simaroubaceæ*. The result of his studies proved that certain anatomical characters differ very much from those of other species of *Simaroubaceæ* thus warrant the forming of the family *Irvingiaceæ* as advanced by PIERRE (16). WEBBER (19), in the study of the systemactic anatomy of the woods of *Simaroubaceæ*, followed ENGLER's (4) major taxonomic divisions of the family represented by six subfamilies, namely, *Surianoideæ*, *Simaruboidæ*, *Kirkioideæ*, *Irvingioideæ*, *Picramnioideæ*, and *Alvaradoideæ*. The West Indian genus *Picrodendron* was excluded as suggested by BOAS (1) and HALLIER F. (8) and JOHN K. SMALL (17) proposed the family *Picrodendraceæ*. This genus, with three or four closely related species, has been referred to four families : *Juglandaceæ*, *Anacardiaceæ*, *Sapindaceæ*, *Simaroubaceæ*; the wood of *Picrodendron* resembles greatly to the woods of *Irvingioideæ*. The study of WEBBER showed further that *Irvingioideæ*, *Picramnioideæ* and *Alvaradoideæ* have distinct types of wood structures and indicated that these subfamilies are each a natural group. Because of distinctive morphological characters other than wood structures, the study proposed an exclusion of these subfamilies from *Simaroubaceæ*. In 1951, EXELL and MENDONCA (5) recognized the family *Irvingiaceæ* as distinct from *Simaroubaceæ*. Other authors still follow the taxonomic arrangement of *Simaroubaceæ* by ENGLER, like GILBERT (7), METCALFE and CHALK (12) and others. In 1962, NOOTEBOOM (13) placed *Irvingiaceæ* as a subfamily of *Simaroubaceæ*, maintaining, among other characters, EDMAN's (3) phytochemical results that *Irvingia* and *Simaruboidæ* have close affinities. He indicated, too, that the leaves of *Irvingia* are extremely similar to those of *Quassia* and *Samadera*. However, NOOTEBOOM admitted that species under *Irvingioideæ* lacked a bitter substance which is characteristic of the quassi family. PIERRE (16) gave a family rank to *Irvingia* and *Klainedoxa* on account of the presence of stipules and lysigenous mucilage cavities in the cortex and pith of branches and petioles. VAN TIEGHEM (18) and HUTCHINSON (9) considered *Irvingiaceæ* as distinct from *Simaroubaceæ*.

Ixonanthaceæ has been placed by ENGLER, GILBERT, METCALFE and CHALK and NOOTEBOOM under *Linaceæ* although as early as 1857, *Ixonanthaceæ* has been already treated as a separate family by PLANCHON (« Ixonantheen », Planchon ex Klotzch (1857)). NORMAND (15), in his work on the woods of the Ivory Coast (Africa), placed *Ochthocosmus* under *Linaceæ*. Again, EXELL and MENDONCA (5) recognized *Ixonanthaceæ* as distinct from *Linaceæ*. HUTCHINSON (9) placed *Ixonanthaceæ* under Order Malpighiales, ahead of *Linaceæ* and *Irvingiaceæ*. In his notes on *Ixonanthaceæ*, FORMAN (6) suggested combining the family with *Irvingiaceæ* because of the addition of *Allantospermum* whose characters are

common to both families. Again, HUTCHINSON (10) affirmed *Ixonanthaceae* as a distinct family and included *Allantospermum borneense* Forman and *Cleistanthopsis multicaulis* Capuron under the family.

OBJECT OF THE STUDY

This study is conducted to help provide new information on the genus in question. Because of the different views expressed about the better placement of *Allantospermum*, the results of this study might in one way or the other, help future authors to delineate as to what family the genus belongs. Some arguments are pointed out on the bases of some existing data on the anatomy of some species of *Irvingiaceae* and *Ixonanthaceae*.

MATERIALS

The specimens used in this study were furnished by Mr. R. CAPURON, forest botanist in Tananarive, Madagascar and Mr. L.S.V. MURTHY of the Office of the Conservator of Forest, Kuching, Sarawak. The wood samples were received by the Division of Wood Anatomy, Centre Technique Forestier Tropical, Nogent-sur-Marne, bearing numbers *CTFw 16861* and *CTFw 16127* for *Allantospermum multicaule* (Capuron) Nootboom and numbers *CTFw 16216* and *CTFw 16217* for *Allantospermum borneense* Forman.

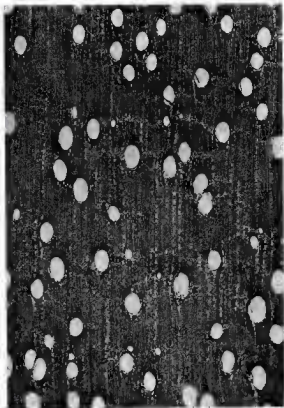
RESULTS

***Allantospermum borneense* Forman (*CTFw 16216* and *CTFw 16217*).**

The wood is orange brown to clear brown, relatively hard to cut with a hand knife and moderately heavy, moderately fine-textured and with a not well-defined cross grain.

MACROSCOPIC EXAMINATION : On the cross-section, growth rings are absent or hardly defined. Through the hand lens, the pores are diffused, mostly solitary, rounded and arranged somewhat tangentially or obliquely. Wood rays hardly visible to the naked eye or seen only with the aid of a hand lens. Parenchyma aliform to confluent easily seen to the naked eye appearing lighter in color than the surrounding tissues.

MICROSCOPIC EXAMINATION : Vessels (pores) diffused-porous, solitary, generally rounded sometimes oval, sometimes occluded with tyloses and arranged obliquely or somewhat tangentially. Pores medium-sized 143 microns (38-243 microns) and moderately few 6 pores per mm². Vessel elements moderately long 932 microns (675-1549 microns) with simple perforations. Intervascular pittings alternate, generally rounded with included apertures, small with an average diameter of 4.5 microns. Rays generally uniseriate, rarely biseriate or triseriate, heterogeneous with from 1 to 4 upright cells located mostly if not all at margins, very numerous 14 par mm, extremely low to very low on an average :



Pl. 1. — *Allantospermum bornesense* Forman : from left to right : Transverse section $\times 25$; Tangential section $\times 55$. — (Photomicrographs Jacqueline Pagès).

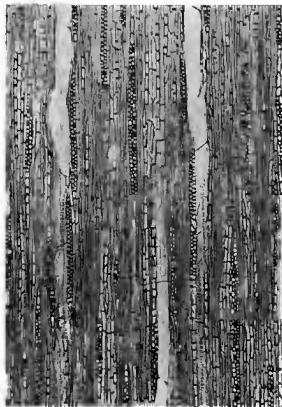
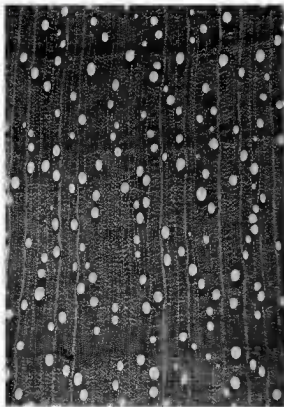
476 microns and very fine 18-23 microns. Presence of vertically-fused rays (1565 microns). Fibers medium-sized 1322 microns (800-1740 microns) very thick (17 microns) with very narrow lumen (3 microns); pits numerous both on the tangential and radial faces. Parenchyma scanty paratracheal, aliform with thin appendages, sometimes unilaterally paratracheal and tending to coalesce to form a not well-defined confluent parenchyma; bands formed mostly 1-cell wide. Also, parenchyma diffuse and in short tangential lines. Presence of small pores always associated with aliform parenchyma. Observed longitudinally, parenchyma about 10 (from 6 to 16 or more) cells per strand. Individual cells narrow about 2 to 3 times longer than its width. Grains of silica present, one grain in each ray cell clearly observed radially.

Allantospermum multicaule (Capuron) Nooteboom (*CTFW 16127* and *CTFW 16861*).

The wood is from pinkish to grayish brown to dark brown. Sapwood lighter in color but not markedly separated from heartwood. Moderately hard to cut with a hand knife, relatively heavy, moderately fine to fine-textured and relatively cross-grained.

MACROSCOPIC EXAMINATION : On the cross-section, growth rings present, irregularly spaced, marked by zones of dense tissues and light-colored concentric paranchymatous tissues. Pores hardly or not visible to the naked eye; through the hand lens pores are very fine, diffused, solitary, rounded to oval and arranged radially or obliquely. Wood rays very fine, hardly seen to the naked eye. Parenchyma appearing in bands of different widths near the growth rings and associated with the vessels, others appearing in bands of one-cell wide in regular reticulate formation, as seen through the hand lens. On both radial and tangential sections, no characteristic features are observable.

MICROSCOPIC EXAMINATION : Vessels (pores) diffuse, solitary, rounded to oval, arranged radially or obliquely, rarely occluded with tyloses partially or wholly, moderately small 69 microns (33-115 microns), moderately numerous 14 per mm², moderately long 839 microns (426-1285 microns), with simple perforations. Intervascular pittings alternate with included apertures, small 4.5 microns. Rays 1 to 3 seriate, biseriate dominating, heterogeneous with an unusually long tail-like upright marginal cells attaining from 1 to several cells and often fusing to another ray to form vertically-fused rays. Very numerous 15 to 16 rays per mm, very low 643 microns (172-1799 microns), moderately fine 28 microns (23-49 microns). Fibers medium-sized 1309 microns (820-1920 microns), and thick-walled (16 microns) with narrow lumen, width 4 microns; pits numerous both on the tangential and radial faces. Parenchyma not well-defined ranging from metatracheal-diffuse to diffuse-in-aggregates, scanty paratracheal and rarely vasicentric. Wavy metatracheal parenchyma of one-cell wide discontinuous and usually broken by scattered or diffused parenchyma among the fiber tissues. Bands of one cell wide are



PL. 2. — *Allantospermum multicaule* (Capuron) Nootboom : from left to right : Transverse section $\times 25$; Tangential section $\times 55$.
— (Photomicrographs, Jacqueline PAQUIS).

closed to each other near the growth rings giving the impression that the bands are composed of several cells wide when observed macroscopically. Observed longitudinally, parenchyma composed from 4 to 10 cells or more per strand. Parenchyma cells narrow, relatively long about 3 to 6 times longer than its width. Presence of solitary oxalate crystals, one in each ray cell as seen radially. Crystals are also observable in rays of transverse and tangential sections.

DISCUSSION OF RESULTS

The main difference between *A. borneense* and *A. multicaule* lies principally on the size and number of vessels (pores), seriation and number of rays, type of parenchyma and the nature of deposits (see Table I.). Macroscopically through the hand lens, the two species can readily be differentiated on the transverse section by the distinctive parenchyma patterns. *A. borneense* has aliform parenchyma with short and narrow appendages, while *A. multicaule* displays a more or less apotracheal pattern of one-cell wide appearing numerous near the growth rings, and in somewhat diffuse-in-aggregates formation among the fiber tissues. Also *A. borneense* is coarser textured than *A. multicaule*.

There is no doubt that *Allantospermum* is a distinct genus, entirely different in anatomical structures than all the genera of *Irvingiaceae*, i.e., *Irvingia*, *Desbordesia* and *Klainedoxa* (see Table II.). In *Allantospermum* species, vessels (pores) are diffuse, generally solitary moderately small to medium-sized, numerous and rarely occluded with tyloses while in some species of *Desbordesia*, *Irvingia* and *Klainedoxa*, vessels (pores) are also diffuse but are solitary or in pore-multiple of 2 to 3, medium-sized to moderately large, few to moderately few, generally filled with tyloses either partially or wholly. Rays in *Allantospermum* species are absolutely heterogeneous whereas in *Irvingiaceae*, they are homogeneous. *Allantospermum* and *Irvingiaceae* species differ also in the types of parenchyma. In *Allantospermum*, parenchyma is difficult to define; it varies from scanty-paratracheal to diffuse-in-aggregates and from aliform to banded of one-cell wide, while in *Irvingiaceae* they are wavy tangential bands of from 1 to 7 cells wide and only occasionally associated with pores. But the most distinct character differentiating *Allantospermum* species from *Irvingiaceae* (*Desbordesia*, *Irvingia* and *Klainedoxa*) is the manner in which the deposits are located. In *Allantospermum* species, the silica or oxalate crystals are located in the lumina of the ray cells, whereas in *Irvingiaceae* species oxalate crystals are found in chambered strands (in chains) of axial parenchyma.

It is interesting to note that in the preliminary investigation on the anatomy of the stems, leaves and petioles of *A. multicaule*, lysigenous or secretory canals are absent. Secretory canals are present in *Desbordesia*, *Klainedoxa* and *Irvingia* species. Dr. METCALFE, as stated by FORMAN (6), asserted to this difference in his findings on the anatomy of *A. borneense*,

TABLE I. GROSS DIFFERENCES IN ANATOMICAL FEATURES BETWEEN *ALLANTOSPERMUM BORNEENSE* FORMAN AND *ALLANTOSPERMUM MULTICAULE* (CAPURON) NOOTEBOOM

SPECIES	VESSELS (PORES)	RAYs	PARENCHYMA	DEPOSITS
<i>Allantospermum borneense</i> Forman	Medium-sized, moderately few; vessel members relatively long because simple perforations at the end.	Generally uniseriate, very rarely 2 or 3-seriate, from 1 to 4 marginal upright cells, very numerous (13-15), very fine.	Scanty paratracheal, aliform with thin and short appendage tending to coalesce to form a not well-defined confluent parenchyma. Diffuse parenchyma scattered among fiber tissues.	Silica found in lumina of ray cells,
<i>Allantospermum multicaule</i> (Capuron) Nootboom	Moderately small, moderately numerous; vessel members a little shorter.	Biseriate dominating, 1 to 3-seriate, with an unusually long upright marginal cells, very numerous (15-16), very fine to moderately fine.	Metatracheal-diffuse or diffuse-in-aggregates. Metatracheal parenchyma more or less wavy of one-cell wide and discontinuous.	Oxalate crystals found in lumina of ray cells.

TABLE II. GROSS DIFFERENCES IN ANATOMICAL FEATURES BETWEEN *ALIANTOSPERMUM* AND SOME SPECIES UNDER THE FAMILY *IRVINGIACEÆ*.

SPECIES	VESSELS (PORES)	RAYS	PARENCHYMA	DEPOSITS
<i>A. borneense</i> and <i>A. multicaule</i>	Diffuse-porous, mostly solitary, moderately small to medium-size, moderately few to moderately numerous, rarely occluded with tyloses. Intervascular pitting, very small to small.	Heterogeneous with 1 to 4 or several marginal or upright cells.	Scanty paratracheal aliform with thin and short appendage to diffuse-in-aggregates with more or less undulating metatracheal band of one cell wide.	Silica or oxalate crystals found in lumina of ray cells.
<i>Desbordesia glaucescens</i> , <i>Irvingia gabonensis</i> and <i>Klainedoxa gabonensis</i>	Diffuse-porous, solitary or in pore-multiple of 2 to 3, medium-sized to moderately large, few to moderately few, filled with tyloses partially or wholly. Intervascular pitting, medium-sized to large.	Homogeneous.	In wavy tangential bands, more or less associated with pores of from 1 to 7 cells wide.	Oxalate crystals found in chambered strands (in chains) of axial parenchyma.

although he did not clearly specify where the canals are found. However, as Mr. NOOTEBOOM said, this lack of lysigenous canals seemed to be a difference between *Allantospermum* and species of *Irvingioideæ*. Morphologically, Mr. NOOTEBOOM included *Allantospermum* to the subfamily *Irvingioideæ*.

The anatomy of the woods (secondary xylem) of *Allantospermum* does not in anyway point its distinct closeness either to the *Irvingiaceæ* or *Ixonanthaceæ* species. However, certain gross anatomical characters of *Allantospermum* tend to be nearer to *Linaceæ sensu lato* than to *Simaroubaceæ sensu lato*. This observation seems to agree with Dr. METCALFE in his description of the species belonging to *Linaceæ* (*Ixonanthes* and *Ochthocosmus*) in having heterogeneous rays with margins of 4 or more rows of square or upright cells. He also pointed out that parenchyma of some species of *Linaceæ* are often difficult to classify as either paratracheal or apotracheal. *Irvingiaceæ* species have banded parenchyma in regular pattern, whereas in *Allantospermum* species, especially *A. multicaule* is difficult to define; it appears diffuse, paratracheal or banded but neither one is distinct. Gross anatomical features of *Irvingiaceæ* species do not agree with *Allantospermum* (see Table II.).

CONCLUSION

The question of whether *Allantospermum* belongs to *Ixonanthaceæ* or *Irvingiaceæ* is highly debatable. Plant systematists would surely argue that their findings are more convincing as those of wood anatomists.

Systematically, anatomy of timbers, in general, is much easier to range by genera than by family. Small families, like *Octoknemaceæ* that includes only of 2 genera and about 8 species, may be shown into 2 very different types of wood pattern as shown by NORMAND (15).

Because of the principle, "the naming of taxonomic group is based on the priority of publication", all botanists will admit that *Cleistanthopsis* Capuron is a synonym of *Allantospermum* Forman. The anatomy of the woods concludes that these are different species, susceptible to be classified in the same genus. As shown by its wood pattern, *Allantospermum* is different from *Ixonanthoideæ* and also from *Irvingioideæ*.

In accord with the view of NOOTEBOOM, *Irvingiaceæ*, firstly very homogeneous in wood structure, is now composed of 3 genera and 45 species with the same type of wood structures (*Irvingia*, *Desbordesia* and *Klainedoxa*) and on the other part, of 1 genus and 2 species with different wood pattern (*Allantospermum*).

However, *Allantospermum*, a distinct genus, as found morphologically and anatomically, should be treated as such whatever family one wishes it to belong.

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LITERATURE CITED

1. BOAS, F. — Beih. Bot. Centralbl. **29** : 1 : 348 (1913).
2. CAPURON, R. — *Adansonia*, ser. **25** : 213-216 (1965).
3. EDMAN, — Svensk. Bot. Tidskr. **30** : 493-514 (1936).
4. ENGLER, A. — Pfl. Fam., ed. 2, **19a** : 396-402 (1931).
5. EXELL, A. W. and MENDONÇA, F. — Consp. Fl. Angol. **1** : 246-8 & 279-281 (1951).
6. FORMAN, L. L. — Kew Bull. **19**, 3 : 517-526 (1965).
7. GILBERT, G. — Flore du Congo Belge et du Ruanda-Urundi **7** : 109-118 (1958).
8. HALLIER, F. — Beih. Bot. Centralbl. **39**, 2 : 62-8 (1923).
9. HUTCHINSON, J. — Fam. Fl. Pl., ed. 2, **1** : 255-277 and 261-3 (1959).
10. — Gen. Fl. Pl. **2** : 592-4 (1967).
11. JADIN, F. M. — Ann. Sc. Nat. ser. 8, **13**, : 201-303 (1901).
12. METCALFE, C. R. and CHALK, L. — Anat. Dicot. **1** : 258-272 & 317-326 (1957).
13. NOOTBOOM, H. P. — Fl. Mal. **1**, 6 : 194-5 (1962).
14. — *Adansonia*, ser. 2, **7**, 2 : 161-68 (1967).
15. NORMAND, D. — Atlas des Bois de la Côte d'Ivoire : **1** : 76-7, 144 & **2** : 178-180 (1950-1955).
16. PIERRE, J. B. L. — Fl. For. Coch. **4** : 263 (1892).
17. SMALL, J. K. — Journ. N. Y. Bot. Gard. **18** : 212; 180-186 (1917).
18. TIEGHEM, V. — Ann. Sc. Nat., ser. 9, Bot. **1** : 247-320 (1905).
19. WEBBER, I. E. — Amer. J. Bot. **23** : 557-587 (1936).